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L8: Entry 4 of 4

File: USPT

Jul 20, 1999

US-PAT-NO: 5925189DOCUMENT-IDENTIFIER: US 5925189 A

TITLE: Liquid phosphorous precursor delivery apparatus

DATE-ISSUED: July 20, 1999

## INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nguyen; Chau	San Jose	CA		
Sivaramakrishnan; Visweswaren	Cupertino	CA		

US-CL-CURRENT: 118/726; 118/715

## CLAIMS:

What is claimed is:

1. An apparatus comprising:  
a sealer in contact with a liquid phosphorous precursor compound;  
said sealer being a polyamide.
2. The apparatus of claim 1 wherein said phosphorous precursor compound comprises TEPO, TMP or TEP.
3. The apparatus of claim 1 wherein said sealer is a shut-off or control plug in a valve.
4. The apparatus of claim 1 wherein said sealer is a gasket.
5. An apparatus for delivering a liquid phosphorous precursor compound, comprising:  
a container for holding said liquid phosphorous precursor compound;  
a conduit for delivering said liquid phosphorous precursor compound or a gaseous product of said liquid phosphorous precursor compound;  
wherein at least a portion of said container or said conduit includes a sealer composed of a polyamide.
6. The apparatus of claim 5 wherein said sealer is a shut-off or control plug in a valve.
7. The apparatus of claim 5 wherein said polyamide is Vespel.
8. The apparatus of claim 5 wherein said apparatus is a bubbler system for delivering gases to a chemical reaction chamber for semiconductor wafers.
9. The apparatus of claim 5 wherein said apparatus is a boiler system for delivering gases to a chemical reaction chamber for semiconductor wafers.
10. The apparatus of claim 5 wherein said apparatus is an injection system for delivering gases to a chemical reaction chamber for semiconductor wafers, and wherein said sealer is a plug in an injection valve.
11. The apparatus of claim 5 wherein said sealer is a gasket.
12. The apparatus of claim 5 wherein said phosphorous precursor compound comprises TEPO, TMP or TEP.
13. The apparatus of claim 5 wherein a portion of said container or said conduit is composed of a stainless steel alloy having less than 5% nickel.
14. An liquid flow injection valve for supplying a liquid phosphorous precursor source to a chemical vapor deposition (CVD) chamber comprising:  
a container of said liquid phosphorous precursor, said liquid phosphorous precursor being one of TEPO, TMP or TEP;  
an injection orifice for connecting to said container; and  
a valve outlet for delivering a gaseous mixture generated from said liquid phosphorous precursor compound to said CVD chamber;

a shut-off or control plug in said valve, said plug being composed of Vespel.  
15. A liquid injection system for a CVD chamber comprising:  
a container for holding liquid phosphorous precursor compound, said liquid phosphorous precursor compound being one of TEPO, TMP or TEP;  
an injection valve for converting said liquid phosphorous precursor into gaseous form, said injection valve having portions in contact with said liquid phosphorous precursor compound composed of a stainless steel alloy having less than 5% nickel and at least 15% chromium;  
a shut-off or control plug in said injection valve, said plug being composed of a polyamide;  
a liquid phosphorous precursor compound injection line coupling said container to said injection valve;  
a carrier gas source line coupled to said injection valve; and  
an outlet line coupling said injection valve to said CVD chamber.

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L8: Entry 3 of 4

File: USPT

Jul 17, 2001

US-PAT-NO: 6261374

DOCUMENT-IDENTIFIER: US 6261374 B1

TITLE: Clog resistant gas delivery system

DATE-ISSUED: July 17, 2001

## INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bang; Won	San Jose	CA		
Chen; Chen-An	Sunnyvale	CA		

US-CL-CURRENT: 118/726; 118/715, 118/723VE, 156/345

## CLAIMS:

The invention claimed is:

1. A gas delivery system comprising:  
a plurality of injection valves, each injection valve having a carrier gas inlet, an outlet and a processing liquid inlet, the processing liquid inlet having an orifice configured to facilitate vaporization of a processing liquid passing therethrough via a pressure drop; and  
a first line having a plurality of inlets, each line inlet operatively coupling one of the injection valves' outlets.
2. The gas delivery system of claim 1 further comprising:  
a single carrier gas source operatively coupled to the carrier gas inlet of each of the plurality of injection valves.
3. The gas delivery system of claim 2 further comprising:  
a first processing liquid source containing a first processing liquid, the first processing liquid source being operatively coupled to a processing liquid inlet of a first one of the injection valves; and  
a second processing liquid source containing a second processing liquid that reacts to form a residue when mixed with the first processing liquid, the second processing liquid source being operatively coupled to a processing liquid inlet of a second one of the injection valves.
4. The gas delivery system of claim 3 wherein the first processing liquid comprises H<sub>2</sub>sub.3 PO<sub>2</sub>sub.4 and the second processing liquid comprises TEOS.
5. The gas delivery system of claim 1 further comprising:  
a first processing liquid source containing a first processing liquid, the first processing liquid source being operatively coupled to a processing liquid inlet of a first one of the injection valves; and  
a second processing liquid source containing a second processing liquid that reacts to form a residue when mixed with the first processing liquid, the second processing liquid source being operatively coupled to a processing liquid inlet of a second one of the injection valves.
6. The gas delivery system of claim 5 wherein the first processing liquid comprises H<sub>2</sub>sub.3 PO<sub>2</sub>sub.4 and the second processing liquid comprises TEOS.
7. A processing system comprising:  
the gas delivery system of claim 1 wherein the first line further comprises an outlet; and  
a processing chamber operatively coupled to the outlet of the first line.
8. The processing system of claim 7 further comprising:  
a single carrier gas source operatively coupled to the carrier gas inlet of each of the plurality of injection valves.
9. The processing system of claim 8 further comprising:

a first processing liquid source containing a first processing liquid, the first processing liquid source being operatively coupled to a processing liquid inlet of a first one of the injection valves; and  
a second processing liquid source containing a second processing liquid that reacts to form a residue when mixed with the first processing liquid, the second processing liquid source being operatively coupled to a processing liquid inlet of a second one of the injection valves.

10. The processing system of claim 9 wherein the first processing liquid comprises H.sub.3 PO.sub.4 and the second processing liquid comprises TEOS.

11. A processing system for chemical vapor deposition of silicon dioxide, comprising:

the processing system of claim 10; and

a third processing liquid source containing a third processing liquid, the third processing liquid source being operatively coupled to a processing liquid inlet of a third one of the injection valves;  
wherein the third processing liquid comprises TEB and the first processing liquid further comprises TEPO.

12. The processing system of claim 7 further comprising:

a first processing liquid source containing a first processing liquid, the first processing liquid source being operatively coupled to a processing liquid inlet of a first one of the injection valves; and

a second processing liquid source containing a second processing liquid that reacts to form a residue when mixed with the first processing liquid, the second processing liquid source being operatively coupled to a processing liquid inlet of a second one of the injection valves.

13. The processing system of claim 12 wherein the first processing liquid comprises H.sub.3 PO.sub.4 and the second processing liquid comprises TEOS.

14. An automated semiconductor device processing system comprising:

a load lock;

a transfer chamber operatively coupled to the load lock;

a wafer handler within the transfer chamber; and

the processing system of claim 7,

operatively coupled to the transfer chamber and to the wafer handler.

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Jul 24, 2001

US-PAT-NO: 6265026  
DOCUMENT-IDENTIFIER: US 6265026 B1

TITLE: Vapor phase deposition

DATE-ISSUED: July 24, 2001

## INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Wang; Yuchun	Albany	CA		

US-CL-CURRENT: 427/248.1; 427/255.23, 427/255.25, 427/255.28

## CLAIMS:

What is claimed is:

1. A method of forming a coating on a surface of an article, comprising: placing a porous article between an upper housing portion and a lower housing portion of a process chamber, the article spanning a cross-section of the process chamber; joining the upper housing portion and the lower housing portion; introducing a liquid coating reagent into a flow passageway extending into the process chamber; flowing a carrier gas through the flow passageway to produce a gas mixture including a vaporized coating reagent and the carrier gas; directing the gas mixture into the process chamber to contact the surface of the article and form the coating thereon; and exhausting the gas mixture from the process chamber.
2. The method of claim 1, further including: flowing the carrier gas through the flow passageway before introducing the liquid coating reagent into the flow passageway and measuring the flow rate of the carrier gas to provide a first flow rate; as the gas mixture is exhausted from the process chamber, measuring its flow rate to provide a second flow rate; and comparing the first flow rate to the second flow rate to determine if the coating procedure has been performed properly.
3. A method of forming a coating on a surface of an article, comprising: placing a porous article between an upper housing portion and a lower housing portion of a process chamber, the article extending across a cross-section of the process chamber; flowing a carrier gas through a flow passageway extending into the process chamber and measuring the flow rate of the carrier gas exiting the process chamber to provide a first flow rate; introducing a liquid coating reagent into the flow passageway extending into the process chamber; flowing the carrier gas through the flow passageway to produce a gas mixture including a vaporized coating reagent and the carrier gas; directing the gas mixture into the process chamber to contact the surface of the article and form the coating thereon; exhausting the gas mixture from the process chamber and measuring its flow rate to provide a second flow rate; and comparing the first flow rate to the second flow rate to determine if the coating procedure has been performed properly.

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File: USPT

Jul 31, 2001

US-PAT-NO: 6267820

DOCUMENT-IDENTIFIER: US 6267820 B1

TITLE: Clog resistant injection valve

DATE-ISSUED: July 31, 2001

## INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Chen; Chen-An	Sunnyvale	CA		
Bang; Won	Santa Clara	CA		

US-CL-CURRENT: 118/726; 118/715, 118/719, 137/605, 239/102.1, 239/398, 239/419,  
239/426, 239/433, 251/129.06

## CLAIMS:

The invention claimed is:

1. An injection valve comprising:  
a vaporization region;  
a processing liquid inlet coupled to the vaporization region;  
a carrier gas inlet coupled to the vaporization region;  
an outlet coupled to the vaporization region for outletting a mixture of carrier gas and vaporized processing liquid; and  
a wave generator operatively coupled to the vaporization region so as to vibrate the vaporization region.
2. The apparatus of claim 1 wherein the processing liquid inlet, the carrier gas inlet and the outlet are formed in an injection block; and wherein the wave generator is coupled to the injection block.
3. A system for processing semiconductor wafers, comprising:  
processing chamber;  
a processing liquid supply system operatively coupled to the processing chamber, and  
the injection valve of claim 2 coupled within the processing liquid supply system, for vaporizing processing liquid to be supplied to the processing chamber.
4. A semiconductor wafer fabrication tool, comprising:  
a wafer transfer chamber having a wafer handler therein;  
a load lock chamber operatively coupled to the wafer transfer chamber; and  
the semiconductor wafer processing system of claim 3, operatively coupled to the wafer transfer chamber.
5. The apparatus of claim 1 further comprising a flexible plate that defines the vaporization region and which is used to close the processing liquid inlet, wherein the wave generator is operatively coupled to the flexible plate.
6. The apparatus of claim 5 further comprising:  
a piezoelectric operatively coupled to the flexible plate, wherein the wave generator is operatively coupled to the piezoelectric.
7. A system for processing semiconductor wafers, comprising:  
a processing chamber;  
a processing liquid supply system operatively coupled to the processing chamber, and  
the injection valve of claim 4 coupled within the processing liquid supply system, for vaporizing processing liquid to be supplied to the processing chamber.
8. A semiconductor wafer fabrication tool, comprising:  
a wafer transfer chamber having a wafer handler therein;  
a load lock chamber operatively coupled to the wafer transfer chamber; and

the semiconductor wafer processing system of claim 7, operatively coupled to the wafer transfer chamber.

9. The apparatus of claim 6 wherein the wave generator is adjustable so as to open the processing liquid inlet, close the processing liquid inlet and vibrate the vaporization region via a voltage signal output to the piezoelectric.

10. A system for processing semiconductor wafers, comprising:  
a processing chamber;

a processing liquid supply system operatively coupled to the processing chamber, and the injection valve of claim 5 coupled within the processing liquid supply system, for vaporizing processing liquid to be supplied to the processing chamber.

11. A semiconductor wafer fabrication tool, comprising:

a wafer transfer chamber having a wafer handler therein;  
a load lock chamber operatively coupled to the wafer transfer chamber; and  
the semiconductor wafer processing system of claim 10, operatively coupled to the wafer transfer chamber.

12. The apparatus of claim 1 further comprising a control valve operatively coupled to the processing liquid inlet, for opening and closing the processing liquid inlet, wherein the wave generator is operatively coupled to the control valve.

13. A system for processing semiconductor wafers, comprising:

a processing chamber;  
a processing liquid supply system operatively coupled to the processing chamber, and

the injection valve of claim 1 coupled within the processing liquid supply system, for vaporizing processing liquid to be supplied to the processing chamber.

14. A semiconductor wafer fabrication tool, comprising:

a wafer transfer chamber having a wafer handler therein;  
a load lock chamber operatively coupled to the wafer transfer chamber; and  
the semiconductor wafer processing system of claim 13, operatively coupled to the wafer transfer chamber.

15. An injection valve comprising:

a vaporization region;  
a processing liquid inlet coupled to the vaporization region;  
a flexible plate that defines the vaporization region and which is used to close the processing liquid inlet;

a piezoelectric operatively coupled to the flexible plate;  
a carrier gas inlet coupled to the vaporization region;  
an outlet coupled to the vaporization region for outletting a mixture of carrier gas and vaporized processing liquid; and

a wave generator operatively coupled to the piezoelectric wherein the wave generator is adjustable so as to open the processing liquid inlet, close the processing liquid inlet and vibrate the vaporization region via a voltage signal output to the piezoelectric.

16. An injection valve comprising:

a plate that defines a vaporization region;  
a piezoelectric coupled to the plate;  
a processing liquid inlet coupled to the vaporization region;  
a carrier gas inlet coupled to the vaporization region;  
an outlet coupled to the vaporization region and adapted to output a mixture of carrier gas and vaporized processing liquid; and  
a wave generator coupled to the piezoelectric wherein the wave generator is adjustable so as to open the processing liquid inlet, close the processing liquid inlet and vibrate the vaporization region via a voltage signal output to the piezoelectric.

17. The apparatus of claim 16 wherein the wave generator outputs a voltage signal of zero volts to open the processing liquid inlet.

18. The apparatus of claim 16 wherein the wave generator outputs a voltage signal having a sonic frequency to vibrate the vaporization region.

19. The apparatus of claim 16 wherein the wave generator outputs a D.C. voltage signal to close the processing liquid inlet.

20. The apparatus of claim 19 wherein the wave generator outputs a voltage signal having both a D.C. voltage to close the processing liquid inlet and a sonic frequency to vibrate the vaporization region.